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Full Length Research Paper

Influence of class size on techniques of teaching science in primary schools of Vihiga County, Kenya

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Kenya re-implemented Free Primary Education (FPE) in January, 2003 leading to an increase in student enrolment in some classes more than in others. This could have had far reaching implications on the quality of education of children. Consequently, this study aimed at establishing the influence of increased student enrolment on the techniques used to teach science in upper primary schools. The study employed descriptive survey research design. The sample size was 108 questionnaire respondents and 36 interview respondents, respectively. However, the study only managed to achieve 116 (90 questionnaire and 26 interview) respondents. Sampling involved multi-stage sampling, purposive sampling, proportionate purposive sampling and simple random sampling. Data collection was done using Questionnaire for Science Teachers (QST) and Science Teachers' Interview Schedule (STIS). The data collected were analyzed using Statistical Package for Social Sciences (SPSS). The significance level of the differences between mean frequencies of use of the teaching techniques was done at the α value of 0.05. The study found that increase in student enrolment influenced use of lecture technique positively while the use of practical, project and assignment techniques were influenced negatively. Such enrolment did not influence demonstration, discussion, field course excursions and question and answer techniques. Consequently, increase in student enrolment impacted negatively on the acquisition of science process skills and attitudes.

Key words: Enrolment, class size, methods of teaching, techniques of teaching.

INTRODUCTION

Background to the Study

One of the aspects of schooling which is related to student achievement, particularly in sciences, is class size (Allen & Lynd, 2000). Kelly (2004) points out that schools did not offer proper science teaching because of class size pressure. This observation, as exemplified by the Tennessee Project Student-Teacher Achievement Ratio (STAR) of 1985 (Colorado Department of Education, 1996) and the Class Size Reduction (CSR) (1996 – 1998) of California (Bohrnalstedt & Brian, 1999), is explained by the fact that learning in the sciences require more apparatus and equipment than in the social sciences. However, the Kenya government only provides money for the acquisition of textbooks but not apparatus and equipment for practical experiments (Republic of Kenya, 2004). Nevertheless, in many schools in the country, parents stick to the attitude that primary education is free. Consequently, they do not supplement the teaching and learning facilities available in schools.

According to Glass (1991), even minor changes in class size affect students' achievement, where children in smaller classes achieve better results than those in larger ones. This is supported by a study that was

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Table 1. Number of Children per Class in Vihiga County Public Primary Schools as at December 2002 and December 2003.

Standard	Enrolment		Increase in enrolment	% Increase in enrolment
	Dec 2002	Dec 2003		
1	21,186	28,706	7,520	35.5
2	20,675	22,217	1,542	7.4
3	20,284	21,027	743	3.7
4	19,856	21,111	1,255	6.3
5	18,279	19,971	1,692	9.3
6	16,998	18,840	1,842	10.8
7	15,478	17,672	2,194	14.2
8	11,461	12,930	1,469	12.8
Total	**144,217**	**162,474**	**18,257**	**12.7**

Source: MOEST (2002b) and MOEST (2003a)

conducted in the United Kingdom in 1980 to find out the factors that influenced effectiveness of schools (The Open University, 1993). The study found that pupils in schools where classes had an average of 24 or fewer pupils made better progress than those in schools with larger classes, particularly those with 29 or more pupils. Nevertheless, although studies show that variation in class size influences student performance, not much research has been done to identify the other circumstances that lead to the change in performance. The changes in student performance are due to a number of factors, which include the teaching techniques employed by teachers (Hopkins, 1998).

In Africa, the large class sizes are mainly attributed to the implementation of Universal Primary Education (UPE). In many African countries, UPE is also referred to as Free Primary Education (FPE). A number of countries have implemented FPE including Malawi in 1994, Uganda in 1997, Lesotho in 2000 and Kenya in 2003. Findings from Malawi show that primary school enrolment started declining in the late 1990s, partly due to poor learning conditions that existed in the schools (Ligomeka, 2002). This could be due to the unfavourable teaching techniques that were used by teachers.

Kenya first implemented FPE in 1974 for Standards 1 to 4 and in 1979 Standard 5 to 7 were included in the FPE programme (Bogonko, 1992). This was also accompanied by a sharp increase in enrolment. The FPE temporarily ended with the introduction of the cost sharing programme in 1985 (Wanyande & Ondieki, 1996). However, the re-implementation of FPE in Kenya in January 2003 witnessed an additional 1.3 million children joining primary schools (Kioko, 2003). This could have compromised the quality of education because of overcrowding in classrooms. World Bank (WB) (1990) argues that overcrowding of students in classrooms demoralizes teachers and discourages their professional commitment. In the process of adjusting to the increase in enrolment, teachers may turn to the more teacher-centred teaching techniques at the expense of the learner-centred ones. This could certainly affect the acquisition of science-process skills and attitudes by public primary school children. Consequently, this is likely to affect student performance in science at higher levels of learning because primary schools act as the foundation for further education (Harris & Hahn, 1986). In the case of Kenya this scenario would affect the government's goal of making the country a newly industrialized, middle income country, by the year 2030 (Kenya Vision 2030, 2007). This is because science equips in the potential manpower requisite skills and attitudes considered important for economic and technological advancement (Hwang, 2004). In addition, some of the knowledge, skills and attitudes acquired in science can be applied in understanding other subjects (Willing, 1990). If the inquiry techniques are not used, then the knowledge, skills and attitudes required in other subjects are likely to be affected. This may eventually affect the quality of the entire education system negatively.

In terms of increased enrolment in Kenya, urban slums, rural areas and arid and semi arid lands (ASALs) were affected most by FPE (Ministry of Education Science and Technology (MOEST), 2003b). Vihiga, one of Kenya's rural counties, enrolled an additional 18,257 children in upper primary schools by December 2003 as compared to the enrolment in December 2002 (Table 1) (Ahambo, 1998). Vihiga county, one of the 47 counties of Kenya, has a population density of 982.55 (Kenya National Bureau of Statistics (KNBS), 2011). This is the highest population density among rural counties and

Table 2. Number of public primary schools, teachers, children and streams in Vihiga County by division as at December 2003.

Division	Number of schools	Number of teachers	Number of children	Number of streams	Number of children per stream	Student: Teacher ratio
Sabatia	51	567	21,127	615	34	37 : 1
Chavakali	43	543	19,007	563	34	35 : 1
Vihiga	62	698	26,301	786	34	38 : 1
Tiriki West	57	630	24,214	701	35	39 : 1
Emuhaya	48	573	23,509	638	37	41 : 1
Luanda	42	626	27,170	682	40	43 : 1
Tiriki East	40	502	21,146	573	38	42 : 1
Total	**343**	**4,139**	**162,474**	**4,558**	**36**	**39 : 1**

Source: MOEST (2003a).

third among all the counties in the Republic of Kenya. The first two counties with the highest population density are Nairobi and Mombasa, which are cities. However, Nairobi and Mombasa have poverty indices of 22% and 37.6%, respectively, while Vihiga county has a poverty index of 41.3%. High population density, where poverty index is high, is associated with social and economic problems as well as environmental degradation. Some of these problems can be solved by knowledge of science.

Vihiga county had 4,360 streams in the public primary schools in the year 2002 (MOEST, 2002b). If the total number of public primary school children in that year (144,217) is divided by the total number of streams, it gives an average of 33 children per stream. In the year 2003 the average number of children per stream rose to 36 (Table 2). Nonetheless, the total number of teachers (4,139) and streams (4,558) in 2003 were not equal. This implies that either some streams went untaught in some lessons or were merged, leading to a further increase in class size. Furthermore, some parents could have transferred their children to private schools or well performing public primary schools that used to charge higher fees, leading to more increase in enrolment in some schools but decrease in others.

It is also significant to note that the change in enrolment did not affect all classes equally. Apart from Standard one, which had the highest percentage increase in enrolment, Standards six, seven and eight of the upper primary school segment were affected most by the increase in enrolment (Table 1). Classes six, seven and eight therefore formed the focus of this study. Class one was not included in this study because, like other lower primary school classes, it mainly deals with enabling learners to acquire oracy, literacy and numeracy rather than the teaching of science (Gammage, 1991). It was therefore necessary to undertake the study in the upper primary classes where the teaching of science is expected to be more protracted and productive. The process of teaching science should be such that the learner is trained in the scientific method and attitude.

Science is an experimental and investigative subject. It takes this approach because knowledge is only true after being proven to be so (Das, 1992). This is the reason why it is important to teach science through the inquiry approach (Victor, 1980). Science learning provides training in scientific method, which involves the appreciation of the existence of a problem and the desire to solve it; the accumulation of facts and data which are pertinent to the problem; the formulation of hypotheses; and logical interpretation of the data (Miller & Blaydes, 1962). It also helps to develop a scientific attitude of mind in the learner, such as curiosity, openness to new ideas, respect for evidence, independence in thinking, and satisfaction in understanding the world around (Johnson & Keeves, 1995).

The general objectives of teaching science in Kenya's primary schools are to enable the learners to be able to acquire basic scientific knowledge; develop: scientific skills such as observation; positive attitudes about self and the environment; and interest in science and science related careers (MOEST, 2002a). In order to achieve these objectives, the learner needs to be actively involved in the learning process. However, the inquiry methods of teaching are quite demanding on the part of the teacher. As Victor (1980) rightfully points out, training learners in scientific method and attitude can enable them to achieve the objectives of science. This is because better teaching focusing on practical inquiry brings about better learning of science (WB, 1997). However, the Kenya Certificate of Primary Education (KCPE) examination does not assess learners in practical skills. Therefore, one can have a very high KCPE score in science but very little evidence of acquisition of scientific skills and attitudes (Clark & Cutler, 1990). Thus, some of the learners who perform well in science at KCPE find it difficult to cope with

Table 3. Sampling procedures and components of the study sampled.

Sampling procedure	Components of the study sampled			
Multistage	Division	School	Class	Stream
Purposive	Division		Class	
Proportionate purposive		School		
Simple random		School		Stream

science when they enter the secondary school level (MOEST, 2001).

The effective teaching of science requires teaching techniques that actively involve learners in the learning process. These include class experiments (practical work), projects, field course excursions, panel or group discussions, assignments, and question and answer techniques. For example, practical work (or class experiment) is ideally suited for learning through inquiry and is the heart and soul of science teaching and learning (Victor, 1980). The technique appeals to all senses, leading to maximum pupil activity as well as motivating the learners (Das, 1992; Walkin, 1982). Similarly, project technique involves a student or groups of students undertaking a project to supplement or apply knowledge and skills acquired in the classroom (Maundu, Sambili & Muthwii, 1998). This is highly activity oriented (Das, 1992) and enables pupils to acquire skills needed for scientific and technological development (Okere, 1996). Field course excursion entails students visiting a specific point or points of interest, outside the classroom, in order to focus on what is the reality in the environment (Ngaroga, 1996). The technique can take advantage of the curiosity of young children to make science learning effective (Farmer & Farrel, 1980). Expository methods like demonstrations and lectures are not highly recommended for teaching science because they do not actively involve learners in the learning process.

The consequences of increased student enrolment on the teaching and learning of science in primary schools could be germane. However, there is no documentary evidence to show how this increase in enrolment influences the choice of methods for teaching science. However, evidence indicates that Kenya's primary schools, like other African countries, are characterised by shortage of professional science teachers and science facilities (Peacock, 2004; Keraro, 2002). Consequently, it can be argued that FPE brought with it considerable challenges to the teaching profession in Kenya. The policy makers and interested parties need to make informed decisions on how to deal with the challenges posed by FPE, particularly in the teaching of science.

STATEMENT OF THE PROBLEM

The principles of science can enable learners to acquire the requisite knowledge, skills and attitudes that can be applicable in social-economic advancement. For the optimum acquisition of scientific knowledge, skills, and attitudes, science needs to be taught using teaching techniques that promote inquiry learning. Nevertheless, the Free Primary Education (FPE) that was re-implemented in Kenya in January 2003 increased the size of some classes. For example, in Vihiga County there was a 10.8%, 14.2% and 12.8% increase in standard six, seven and eight enrolment, respectively, in the year 2003. Moreover, while it is the policy of the Kenya government to provide free education to every child, the quality of such education should be safeguarded. In the wake of the increased student enrolment, it is not clear if such quality is guaranteed. The effect of the increase in the enrolment could be far reaching on the effectiveness of teaching and learning of science in primary schools. This is because teachers could have easily employed teaching strategies that do not require extra effort for both teachers and pupils. This study set out to find the effect of increased class sizes on the choice of teaching techniques by teachers of science in primary schools of Vihiga county,Kenya.

METHODOLOGY

This study employed the descriptive survey research design and was conducted in Vihiga County of Kenya. The county was selected because it is a rural county, leading in population density among rural counties in Kenya, but characterised by high poverty level (Ahambo, 1998; Kenya Open Data, 2012; KNBS, 2011). High population density together with high poverty level could lead to social and economic problems. It could also lead to environmental degradation. Some of these problems can be solved by knowledge of science. Moreover, the target population was 1,457 teachers. The accessible population was all upper primary school science teachers who were already teaching by the year 2002.

Sampling involved multi-stage sampling, purposive sampling, proportionate purposive sampling and simple random sampling. Multi-stage sampling was used to select the divisions, schools, classes and the streams that provided the teachers who took part in the study (Table 3). The divisions that were included in the study were selected purposively. They were the one that registered the lowest percentage increase in enrolment (Tiriki West),

Table 4. Number of children in upper primary schools in Vihiga County, by division, as at December 2002 and December 2003.

Division	Number of children		% Change in enrolment
	December 2002	December 2003	
Sabatia	6,514	7,170	10.1
Chavakali	5,305	6,079	14.6
Emuhaya	6,301	7,087	12.5
Luanda	6,723	7,644	13.7
Tiriki East	5,396	6,239	15.6
Tiriki West	6,710	7,246	8.0
Vihiga	6,988	7,983	14.2
Total	**43,937**	**49,448**	**12.5**

Source: MOEST (2002b) and MOEST (2003a).

the one that registered medium percentage increase in enrolment (Luanda) and the one that registered the highest percentage increase in enrolment (Tiriki East) (Table 4).

Proportionate purposive sampling was employed to select the schools whose teachers took part in the study. A list of all schools in each of the sample divisions, arranged in order from the school that registered the highest percentage increase in upper primary school enrolment to the one that registered the lowest percentage increase in the enrolment was prepared. Schools that reduced in enrolment were not included in the study.

The required sample schools from each division were then divided into two equal portions. One portion was selected starting from the school that registered the lowest percentage increase in upper primary school enrolment and the other portion was selected starting from the school that registered the highest percentage increase in the enrolment. After selecting the schools, four of them from each of the sample division were used to provide upper primary school science teachers who were interviewed. Of the four schools, two were selected by simple random sampling from the schools that registered a lower percentage increase in enrolment. The other two schools were selected by the same procedure from the schools that registered a higher percentage increase in the enrolment.

From each of the schools, one Standard 6, one Standard 7 and one Standard 8 science teachers were purposively selected for the study. This is because these were the only upper primary school classes that had the highest percentage increase in enrolment (Table 1). The remaining sample schools provided the Standard 6, 7 and 8 science teachers who were respondents to questionnaires. For the classes that had more than one stream, simple random sampling was used to select the stream whose teacher took part in the study. Table 3 shows sampling procedures and components of the study sampled.

The sample size was 108 questionnaire respondents, with 54 selected from schools that registered a higher percentage increase in upper primary school enrolment and another 54 from schools that registered a lower percentage increase in the enrolment. In turn 36 teachers (18 from the former category and another 18 from the latter category) formed the interview sample. The sample size of 108 questionnaire and 36 interview respondents (a total of 144 teachers), respectively, is considered adequate for the study. Gall, Borg and Gall (1996) and Kathuri and Pals (1993) recommend a minimum sample size of 100 and 20-50 individuals for the major and minor subgroups, respectively, in a descriptive survey research. However, the study only managed to engage 90 questionnaire respondents and 26 interview respondents (giving a total of 116 teachers).

The study investigated the frequency of use of eight techniques of teaching. These are lecture, demonstration, discussion, question and answer, project, practical work, field course excursions and assignment. These formed the dependent variables. The independent variable was class size. Some teachers might have undertaken in-service training focusing on how to teach science in crowded classes. In-service training therefore formed an extraneous variable.

The instruments for data collection were questionnaire and interview schedule. Questionnaire for Science Teachers (QST) and Science Teachers Interview Schedule (STIS) were used for data collection. The frequency of use of the teaching techniques was measured on a scale that ranged from 1 (Never used), 2 (Very rarely used), 3 (Rarely used), 4 (Frequently used), and 5 (Very frequently used). The significance of the difference between the means was determined using t-statistic and the significance level was at the alpha value of 0.05. The analysis of the data was done using Statistical Programme for Social Sciences (SPSS).

Table 5. Comparison of teaching methods between the period before and after implementation of FPE for schools that registered a higher percentage increase in the enrolment as measured by QST.

Teaching method before and after implementation of FPE	Mean frequency of use	Standard error	t	Sig. (2-tailed)
Lecture: Before FPE	2.71	.159	-.394	.695
After FPE	2.77			
Demonstration: Before FPE	3.98	.119	-1.646	.107
After FPE	4.17			
Discussion: Before FPE	4.10	.129	-.645	.522
After FPE	4.19			
Question/Answer: Before FPE	4.48	.087	.240	.811
After FPE	4.46			
Project: Before FPE	3.35	.134	4.965	.000
After FPE	2.69			
Practical: Before FPE	3.96	.166	3.398	.001
After FPE	3.40			
Trips: Before FPE	2.17	.133	.313	.755
After FPE	2.13			
Assignment: Before FPE	4.48	.174	3.000	.004
After FPE	3.96			

N = 48

Df = 47

RESULTS AND DISCUSSIONS

The study set out to determine the effect of class size on the choice of teaching techniques used by teachers of science in the primary schools before and after the implementation of the FPE in Vihiga County, Kenya. In addition, the reasons for the choice of the teaching techniques in various situations were explored. The results are thematically presented below:

Effect of class size on choice of teaching techniques in science

The frequency with which a teaching technique is used by the teachers of science implies preference for it based on various reasons and situations. A comparison is therefore made regarding this preference for schools that registered a higher percentage increase in the enrolment as per the responses on the QST. The results are as presented in Table 5.

The results in Table 5 show that teachers in the schools which registered a higher percentage increase in the enrolment slightly increased the frequency of use of lecture technique from 2.71 before implementation of FPE to 2.77 after implementation of FPE. However, t-test between the two means, at the alpha value of 0.05, shows that there is no significant difference between them. Similarly, the teachers slightly increased the frequency of use of demonstration technique from 3.98 before implementation of FPE to 4.17 after implementation of FPE. The t-test shows that there is no significant difference between the means, because $p>0.05$. Thus, increase in student enrolment brought about a slight increase in the frequency of use of the two techniques.

With regard to the frequency of use of the discussion technique, the teachers increased its use from 4.10 before implementation of FPE to 4.19 after implementation of FPE. The t-test shows that the difference between the means is not significant because $p > 0.05$. Conversely, the frequency of use of question and answer technique slightly reduced from 4.48 before implementation of FPE to 4.46 after implementation of FPE. However, t-test between the two means, at the alpha value of 0.05, shows that the difference between them is not significant.

Regarding the frequency of use of project technique, it is observed that this reduced from 3.35 before implementation of FPE to 2.69 after implementation of FPE and t-test between the two means, at the alpha value of 0.05, shows that the difference between them is significant. Similarly, the teachers' frequency of use of practical work technique reduced from 3.96 before implementation of FPE to 3.40 after implementation of FPE. The t-test between the two means, at the alpha value of 0.05, shows that the difference between them is significant. Thus, increase in student enrolment after implementation of FPE influenced the choice of these two techniques negatively.

The teachers also reduced the frequency of use of field course excursions from 2.17 before implementation of FPE to 2.13 after implementation of FPE. However, t-test between the two means, at the alpha value of 0.05, shows that the difference between them is not significant. In the same manner the teachers reduced the frequency of use of the assignment technique from

Table 6. Comparison of teaching techniques between the period before and after implementation of FPE for schools that registered a lower percentage increase in the enrolment as measured by QST.

Teaching method before and after implementation of FPE	Mean frequency of use	Standard error	t	Sig. (2-tailed)
Lecture: Before FPE	3.64	.199	1.918	.062
After FPE	3.26			
Demonstration: Before FPE	3.81	.141	-1.346	.186
After FPE	4.00			
Discussion: Before FPE	4.00	.087	-1.635	.110
After FPE	4.14			
Question/Answer: Before FPE	4.29	.127	-1.311	.197
After FPE	4.45			
Project: Before FPE	2.81	.151	1.423	.162
After FPE	2.60			
Practical: Before FPE	3.81	.144	-.662	.512
After FPE	3.90			
Trips: Before FPE	2.12	.120	.595	.555
After FPE	2.05			
Assignment: Before FPE	4.12	.130	-2.386	.020
After FPE	4.43			

N = 42

Df = 41

4.48 before implementation of FPE to 3.96 after implementation of FPE; the t-test between the means shows that the difference is significant at the alpha value of 0.05. Increased enrolment here negatively influenced the use of assignment technique.

The results for the schools that registered a lower percentage increase in enrolment regarding the teachers' frequency of use of the techniques are as summarised in Table 6.

Regarding the use of lecture technique by the teachers in the schools that registered a lower percentage increase in enrolment, the frequency dropped from 3.64 before implementation of FPE to 3.26 after implementation of FPE. Although these shows a change from frequent to rare, the difference between the two means is not significant at the alpha value of 0.05. Moreover, although both the schools that registered a higher and a lower percentage increase in the enrolment did not show a significant difference in the means, schools that registered a higher percentage increase in enrolment increased its frequency of use while those that registered a lower percentage increase in the enrolment reduced its frequency of use, implying that increased enrolment affected the frequency of use of the technique positively.

In relation to the frequency of use of demonstration technique, the teachers in the schools that registered a lower percentage increase in the enrolment slightly increased its frequency of use from 3.81 to 4.00. The t-test shows that there is no significant difference between the means, because $p>0.05$. This shows a similar trend as with the schools that registered a higher percentage increase in the enrolment, implying that increased enrolment did not affect the frequency of use of demonstration technique.

Regarding the frequency of use of the discussion technique by the teachers in the schools that registered a lower percentage increase in the enrolment, this increased from 4.00 before implementation of FPE to 4.14 after implementation of FPE. However, the t-test shows that the difference between the means is not significant because $p > 0.05$. On the other hand, the teachers increased the frequency of use of the question and answer technique from 4.29 before implementation of FPE to 4.45 after implementation of FPE. In addition, t-test between the two means, at the alpha value of 0.05, shows that the difference between them is not significant. Consequently, in addition to the difference between the means not being significant, because the trend in the frequency of use of discussion technique between the schools that registered a higher and a lower percentage increase in the enrolment is the same, then increase in enrolment did not affect its frequency of use. However, although the results show that schools that registered a higher percentage increase in enrolment slightly reduced the frequency of use of question and answer technique while those that registered a lower percentage increase in the enrolment slightly increased its frequency of use, the fact that the means did not show a significant difference implies that increase in enrolment did not affect its frequency of use.

Moreover, teachers in the schools that registered a lower percentage increase in the enrolment reduced the frequency of use of the project technique from 2.81 before implementation of FPE to 2.60 after implementation of FPE and t-test between the two means, at the alpha value of 0.05, shows that the difference between them is not significant. Nevertheless, although the two pairs of means for both the schools that registered a higher percentage

Table 7. Teachers' reasons for use of teaching techniques after implementation of FPE in schools with higher enrolment rate and those with lower enrolment rate as measured by STIS.

Teaching technique used after implementation of FPE	Reason for use of technique in higher enrolment schools	Percentage Response	Reason for use of technique in low enrolment schools	Percentage Response
Lecture	-Overcrowding	63.7	-Lack of adequate time for planning	70.0
	-Other	36.3	-Other	30.0
Demonstration	-Lack of adequate apparatus	65	-Teachers' attendance of seminars/in-service	68.5
	-Others	35	-Others	31.5
Discussion	-Provision of textbooks by government	60.2	-Teachers' attendance of in-service/seminars	58.6
	-Others	29.8	-Others	41.4
Question and Answer	-Reaching majority of students	89.7	-Reaching most students	90.0
	-Others	10.3	-Others	10.0
Project	-Lack of adequate time	72.5	-Lack of money	75.4
	-Others	27.5	-Others	24.6
Practical work	-Lack of apparatus	68.6	-Lack of adequate time for preparation	67.8
	-Others	31.4	-Others	32.2
Field course excursions	-Lack of funds	80	-Time consuming	79.5
	-Others	20	-Others	20.5
Assignments	-Hard work to mark	91.3	-Difficult to mark	89.3
	-Others	08.7	-Other	10.7

increase in enrolment and those that registered a lower percentage increase in the enrolment show the same trend, the fact that schools that registered a higher percentage increase in the enrolment show a significant difference while those that registered a lower percentage increase in the enrolment do not show a significant difference implies that increase in enrolment affected project technique negatively. On the other hand, teachers in the schools that registered a lower percentage increase in the enrolment increased the frequency of use of the practical work technique from 3.81 before implementation of FPE to 3.90 after implementation of FPE. However, t-test between the two means, at the alpha value of 0.05, shows that the difference between them is not significant. Consequently, the fact that schools that registered a higher percentage increase in enrolment significantly reduced the frequency of use of practical technique while those that registered a lower percentage increase in the enrolment slightly increased the frequency of use of the technique implies that increase in enrolment affected practical technique negatively.

The teachers in the schools that registered a lower percentage increase in enrolment reduced the frequency of use of field course excursions from 2.12 before implementation of FPE to 2.05 after implementation of FPE and the difference between the two means is not significant at the alpha value of 0.05. Consequently, the fact that both the schools that registered a higher percentage increase in enrolment and those that registered a lower percentage increase in the enrolment reduced the frequency of use of field course excursions, although not significantly, implies that increase in student enrolment did not affect the frequency of use of this technique. Furthermore, the teachers in the schools that registered a lower percentage increase in enrolment increased the frequency of use of the assignment technique from 4.12 before implementation of FPE to 4.43 after implementation of FPE. The t-test between the means shows that the difference between them is significant at the alpha value of 0.05. However, the fact that the schools that registered a higher percentage increase in enrolment significantly decreased the frequency of use

of assignment technique while the schools that registered a lower percentage increase in the enrolment significantly increased its frequency of use implies that increase in enrolment affected the technique negatively.

Key reasons for choice of teaching techniques in science after implementation of FPE

It became necessary to determine one key reason each for the observed results in the frequency of the use of each of the eight teaching techniques. The most selected reasons for each technique are as presented in Table 7.

The teachers in the schools that registered a higher percentage increase in the enrolment increased the frequency of use of the lecture technique while those in the schools that registered a lower percentage increase in the enrolment reduced its frequency of use. The key factor that made teachers to increase the frequency of use of lecture technique was overcrowding in classrooms; lecturing naturally provides room for the teachers to communicate with as many students as possible in the class (Farmer & Farrel, 1980). On the other hand, most teachers in the schools that registered a lower percentage increase in the enrolment opted to use lecture technique because they did not have adequate time to prepare lessons and teach using other techniques. This could be attributed to the fact that the total number of primary school streams in Vihiga County was more than the number of teachers, thus teachers were overloaded (Table 2).

With regard to the frequency of use of demonstration technique, there was a slight increase both in the schools that registered a higher percentage increase in upper primary school enrolment and those that registered a lower percentage increase in the enrolment (Tables 5 and 6). The teachers from schools with a higher enrolment rate cited lack of adequate apparatus. This is partly because while implementing FPE, no mechanism was put in place to enable schools acquire other teaching and learning materials apart from textbooks. The teachers in the schools with lower percentage increase in enrolment cited attendance of seminars and in-service courses as a key reason for the use of the technique. Such programmes are in line with World Bank's (WB's) (1997) argument that efficient and effective in-service and pre-service education for teachers and availability of textbooks improve the quality of teaching.

Moreover, in both categories of schools, the frequency of use of discussion technique increased after the implementation of FPE. This was attributed to the teachers' attendance of seminars, in-service courses and the provision of textbooks, through government funding. These enabled students and teachers to get the information used to initiate and sustain the discussions (Ngaroga, 1996).

Furthermore, the findings indicate that teachers in the schools that registered a higher percentage increase in the enrolment slightly decreased the frequency of the use of the question and answer technique from 4.48-4.46. Although this change looks negligible, the frequency of use of the technique is very high. The technique was also popular in the schools that had a low enrolment rate. The teachers attributed this to the effort to reach majority of the students.

In both categories of schools, the use of project technique was not popular after the implementation of FPE. The two key factors for this observation are: lack of adequate time to cover the syllabus and the money to support and sustain the projects. However, teachers in the schools that registered a higher percentage increase in the enrolment could have spent more time dealing with the extra students hence diminishing the time that could have been spent on projects (Das, 1992; Maundu et al, 1998).

Teachers in the schools that registered a higher percentage increase in the enrolment reduced the frequency of the use of practical work technique. They attributed this to the lack of apparatus to meet the needs of the increased number of students. On the other hand teachers in the schools that registered a lower percentage increase in the enrolment increased the frequency of use of the technique. However, the fact that the number of streams in Vihiga County schools was more than the total number of teachers implies that some teachers lacked enough time to plan for the practical lessons (Table 2). This echoes Keraro's (2002) findings that practical science teaching is constrained by lack of enough time and limited facilities. This is because practical technique needs a lot of time, both during planning and delivery (Das, 1992; Maundu et al, 1998). Hence, instead of planning for the practical lessons, the teachers spent the time dealing with the extra students.

However, the findings showed that the reduction in the frequency of use of field course excursion was mainly due to lack of sufficient funds and the fact that the technique is time consuming. This is because although some trips require money, the government does not want parents to be charged extra levies. Furthermore, the teachers observed that class size did not affect the frequency of the use of trips because the maximum capacity of most school buses which are used by most schools for trips is more than 40, a stream as recommended by the government of Kenya.

The fact that teachers in the schools that registered a higher percentage increase in enrolment decreased the frequency of the use of assignment technique and those in the schools that registered a lower percentage increase in the enrolment increased the frequency of its

use was attributed to the fear of the amount of work involved in marking. This tends to confirm UNESCO's research, which found that teachers in overcrowded schools gave fewer assignments (Ramani, 2005). Nevertheless, although teachers in the schools that registered a lower percentage increase in enrolment increased the frequency of use of assignment technique, the bulk of the assignments could have reduced in order to ease the burden of marking. This is likely to affect the quality of science education negatively because frequent assignments, testing and feedback usually result in higher achievement (Saxena, Singh and Gupta in WB, 1997).

CONCLUSIONS

This study concludes that the increase in student enrolment occasioned by the Free Education Programme influenced the choice of the teaching techniques used in the teaching of science. For some of the teaching techniques, the increase in student enrolment increased their frequency of use; for others, the increase in student enrolment reduced their frequency of use and yet for others, the increase in student enrolment did not affect their frequency of use. For example increase in student enrolment influenced use of lecture technique positively, while practical, assignment and project techniques were influenced by such enrolment negatively. However, increase in student enrolment did not affect discussion, demonstration, question and answer and field course excursion techniques.

The major reasons for adopting the use of particular teaching techniques in the teaching of science in primary schools varied from those that are directly or indirectly related to the number of students to those that are not related to the number of students. For example, overcrowding influenced the choice of lecture technique while lack of adequate time and apparatus influenced the choice of project and practical techniques, respectively. The inadequacy could be due to the larger number of students teachers needed to attend to. For the assignment technique, the amount of time and effort (hard work) required in marking and revising the students' work given their large numbers influenced its choice.

It is noteworthy that while the more popular choice of teaching techniques like lecture, and demonstration is occasioned by the ease of teaching large classes, they don't endear themselves to helping the learners develop scientific skills and attitudes. Similarly, the unpopular choice of other techniques such as project and class practicals is precipitated by the ability to organise learners and the learning environment that is very demanding to both the teachers and the learners. Consequently, because the teaching technique used affects the acquisition of science process skills and attitudes; it can be concluded that the increase in upper primary school student enrolment impacted negatively on the quality of science teaching and learning.

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